3D Reconstruction of ArgoNeuT straightline tracks in LArSoft

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LNGS

3D Geometrical Reconstruction

1) Geometrical 3D Reconstruction with Analytical approach
2) Hit by Hit Geometrical 3D Reconstruction

    In future could be re-used also on non-straightline clusters

1) Geometrical 3D Reconstruction with Analytical approach

The final reconstructed object is a 3D line (recob::Track) that can be expressed through the parametric form:

$$\begin{cases} x = x_0 + ta \\ y = y_0 + tb \\ z = z_0 + tc \end{cases} \quad t \in \mathbb{R}$$

Track origin

Parameter

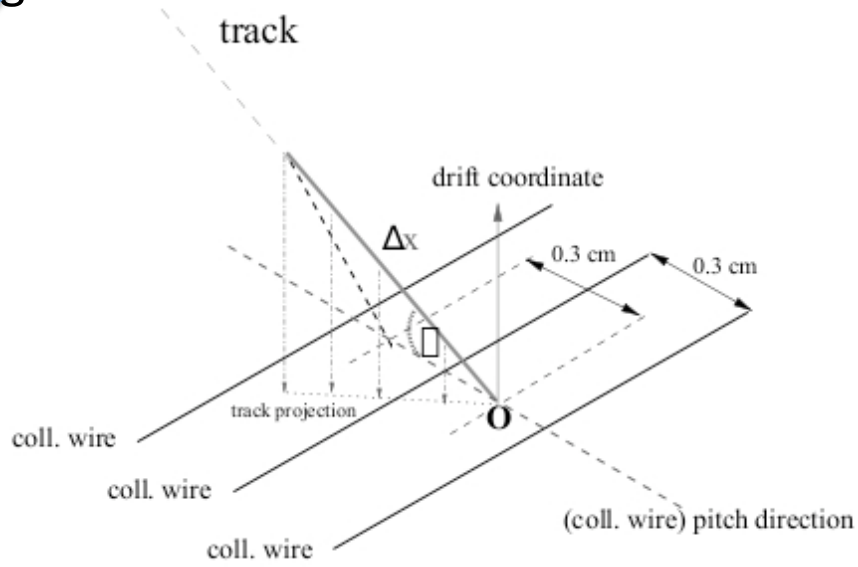
Direction Cosines

1) Analytical Approach: Procedure

- Get Clusters (recob::Cluster)
- Perform simple line fit over the hits of each cluster and extract the geometrical 2D track parameters (slope, intercept, end-points). Create one 2D track for each cluster.
- Extract, for each View, the 2D vertex (if any) through the 2D tracks intersection.
- Compute the coordinate of the vertex 3D (recob::Hit) from the 2 2D vertices.
- Match 2D tracks between the 2 different views (Collection and Induction); two tracks are matched if their end-points are close in time and have "compatible" wire numbers
- Compute the direction cosines, ϑ, ϕ, Δx of the 3D track combining the geometrical parameters of the 2 matched tracks.
- Create the 3D track (recob::Track) with origin in the 3D vertex.
- Display the track with its end-points

Strict Geometrical condition

Tolerance Parameter: tmatch (time sample)
now using 22 sample < ----- > 0.7 cm



2) Hit by Hit Geometrical 3D Reconstruction (I)

- Get a couple of 2D tracks (from ind. and coll.) that have been already matched
- Match their hits. Two hits (Coll and Ind) are matched when they are close in time and when their relative distance from the respective 2D vertex is the same
- Create one 3D Hit for each couple of 2D Hits
- Display the 3D Hits collection

2) Hit by Hit Geometrical 3D Reconstruction (II)

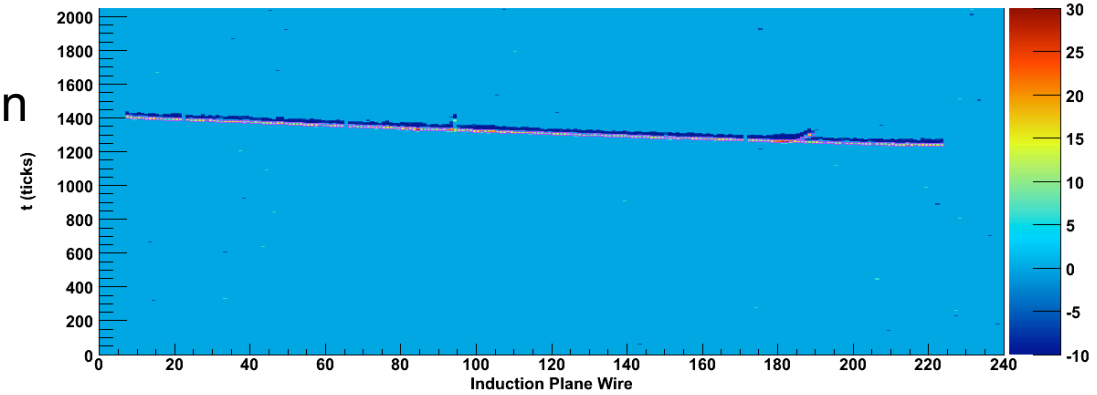
- Algorithm Tested on muon events → refinement possible (work in progress)
- Algorithm adjustment to reconstruct neutrino events → just started

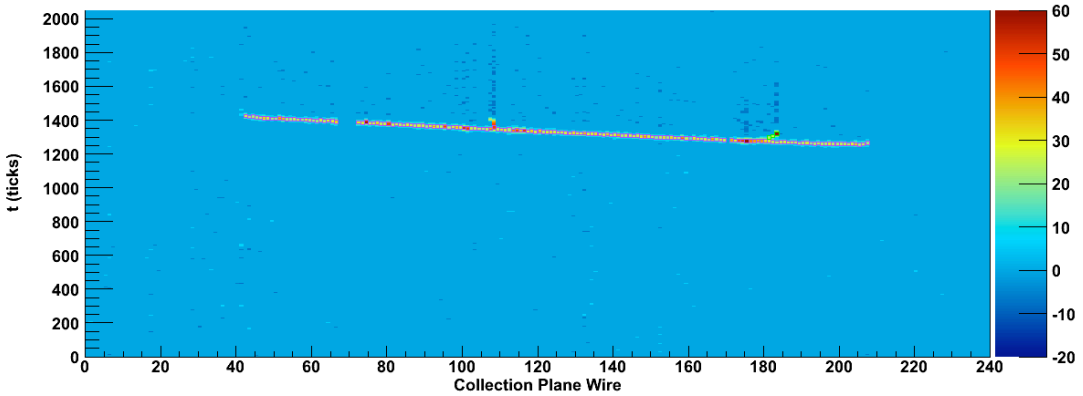
- Next step: start from HoughTransform output → this could improve the results.

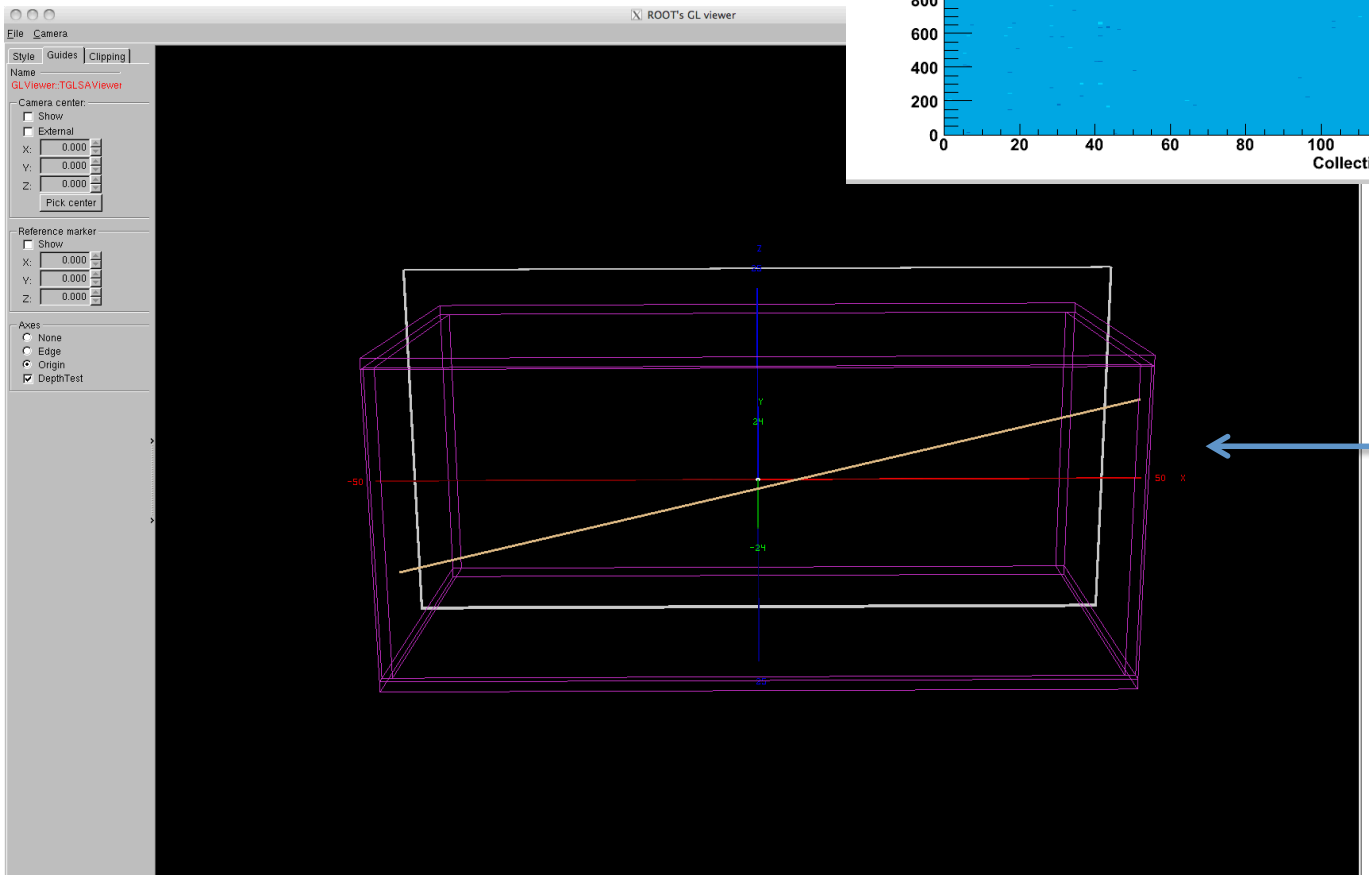
Run 628 Event 1374: crossing muon

Analytical Reconstruction

ϑ = 104°; φ = 93°;
Track Length = 95 cm;





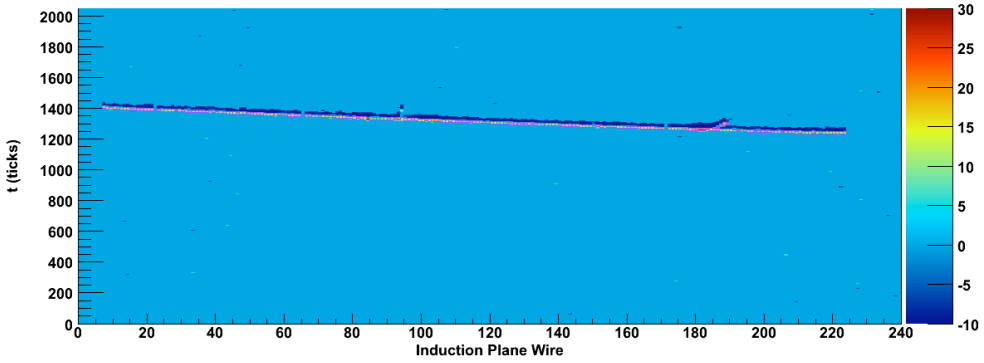


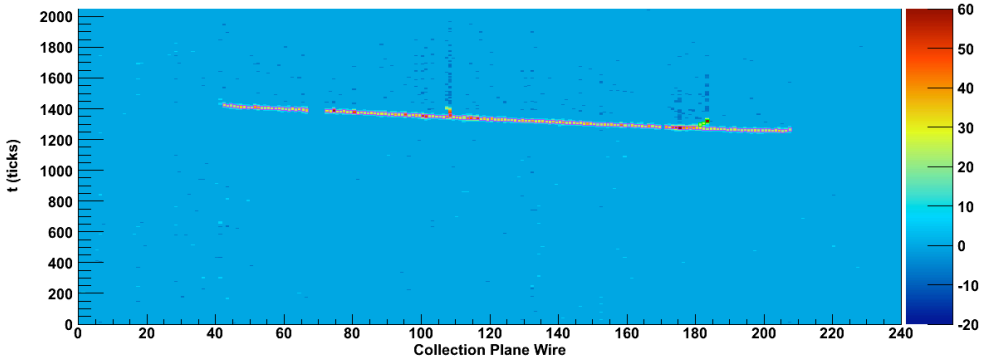
BEAM DIRECTION

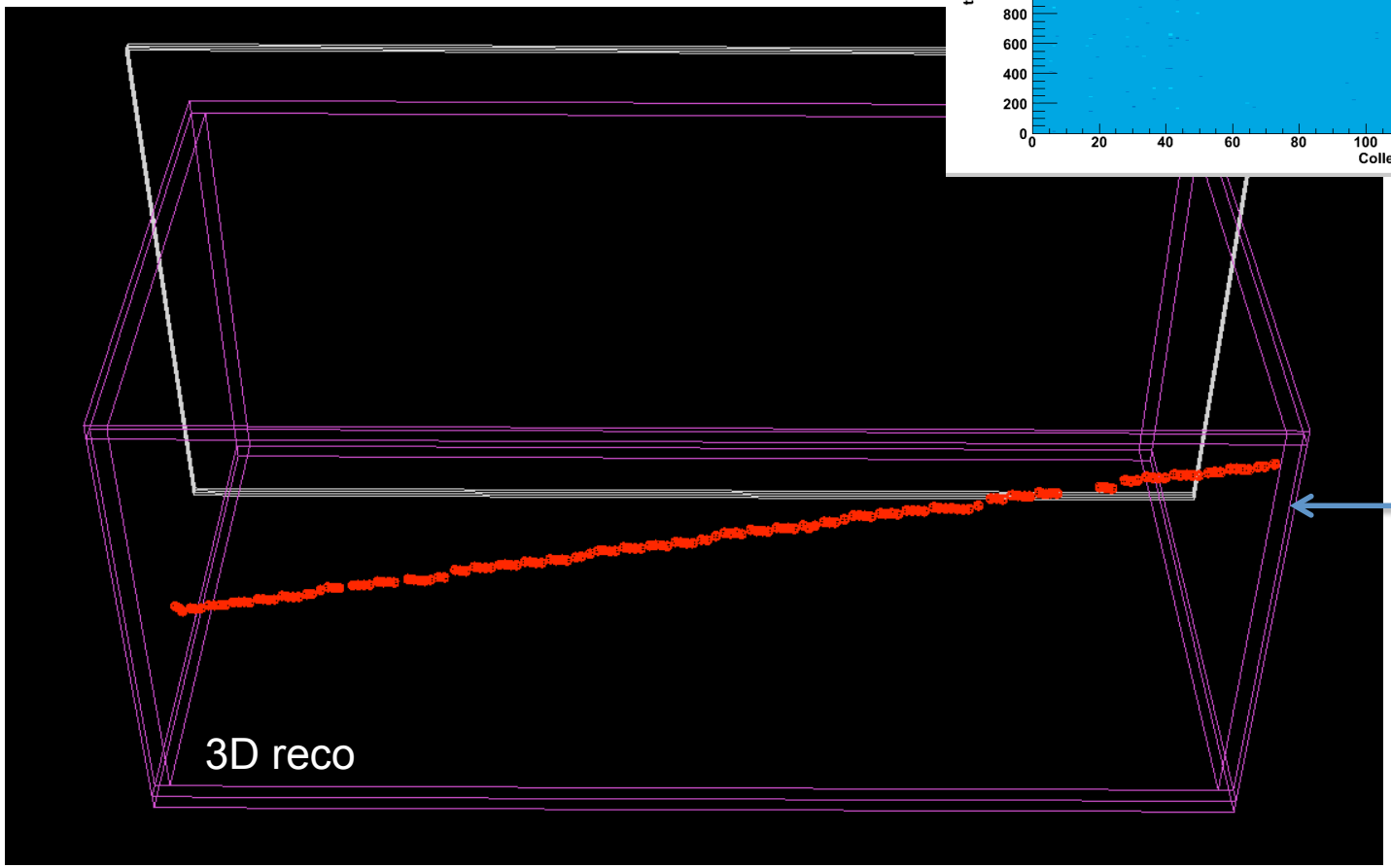
Run 628 Event 1374: crossing muon

Hit by Hit Reconstruction

ϑ = 104°; φ = 93°;
Track Length = 95 cm;





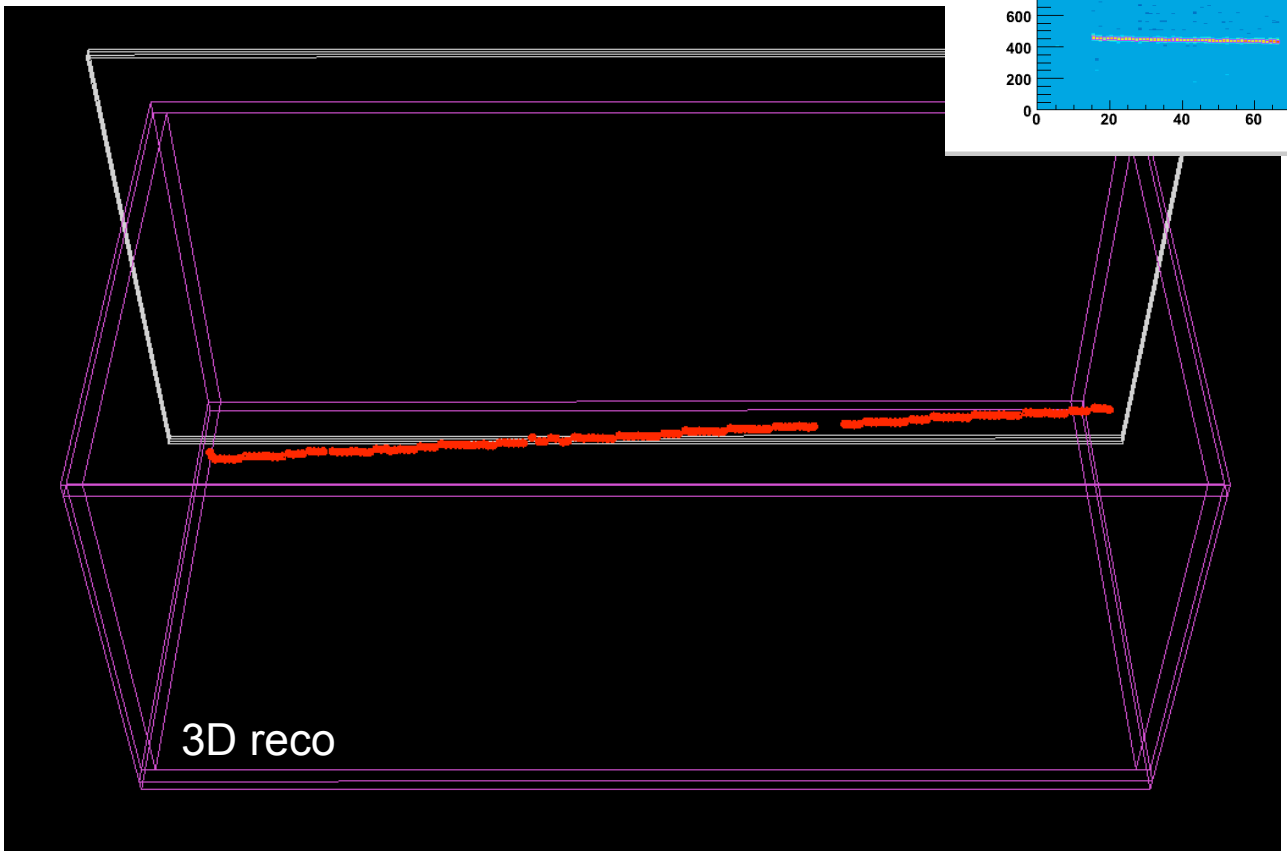


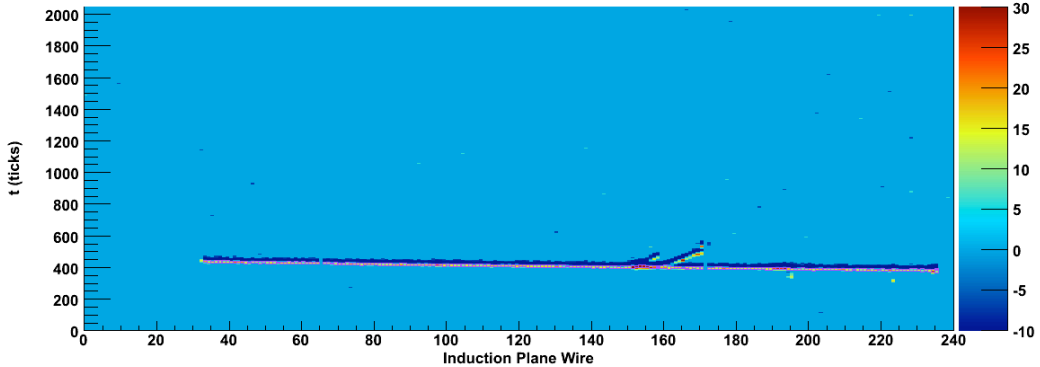
BEAM DIRECTION

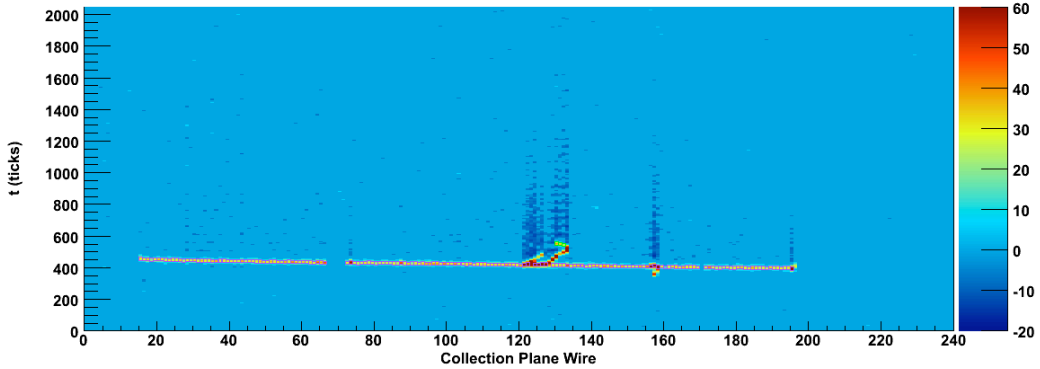
Run 628 Event 1586: crossing muon

Hit by Hit Reconstruction

ϑ = 100°; φ = 91°;
Track Length = 93 cm;





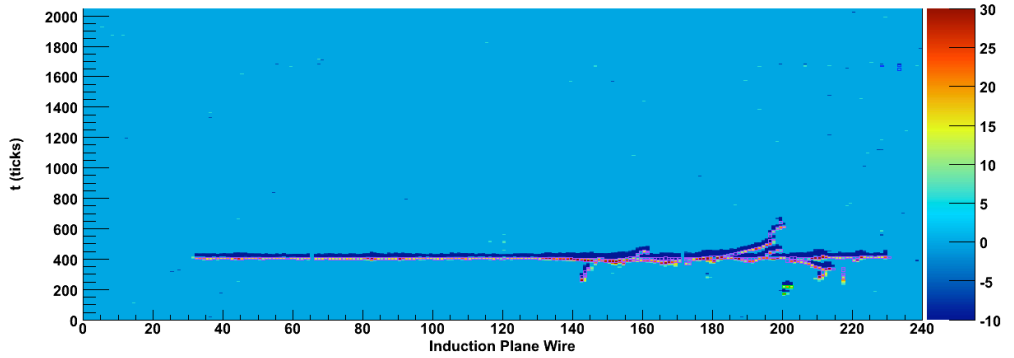


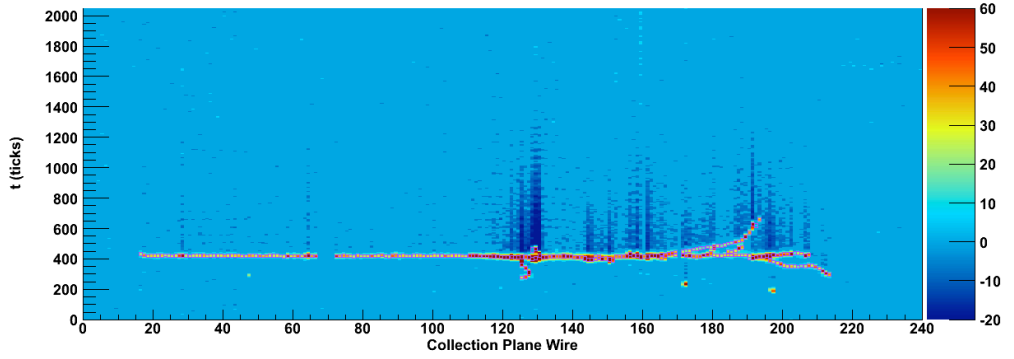
BEAM DIRECTION

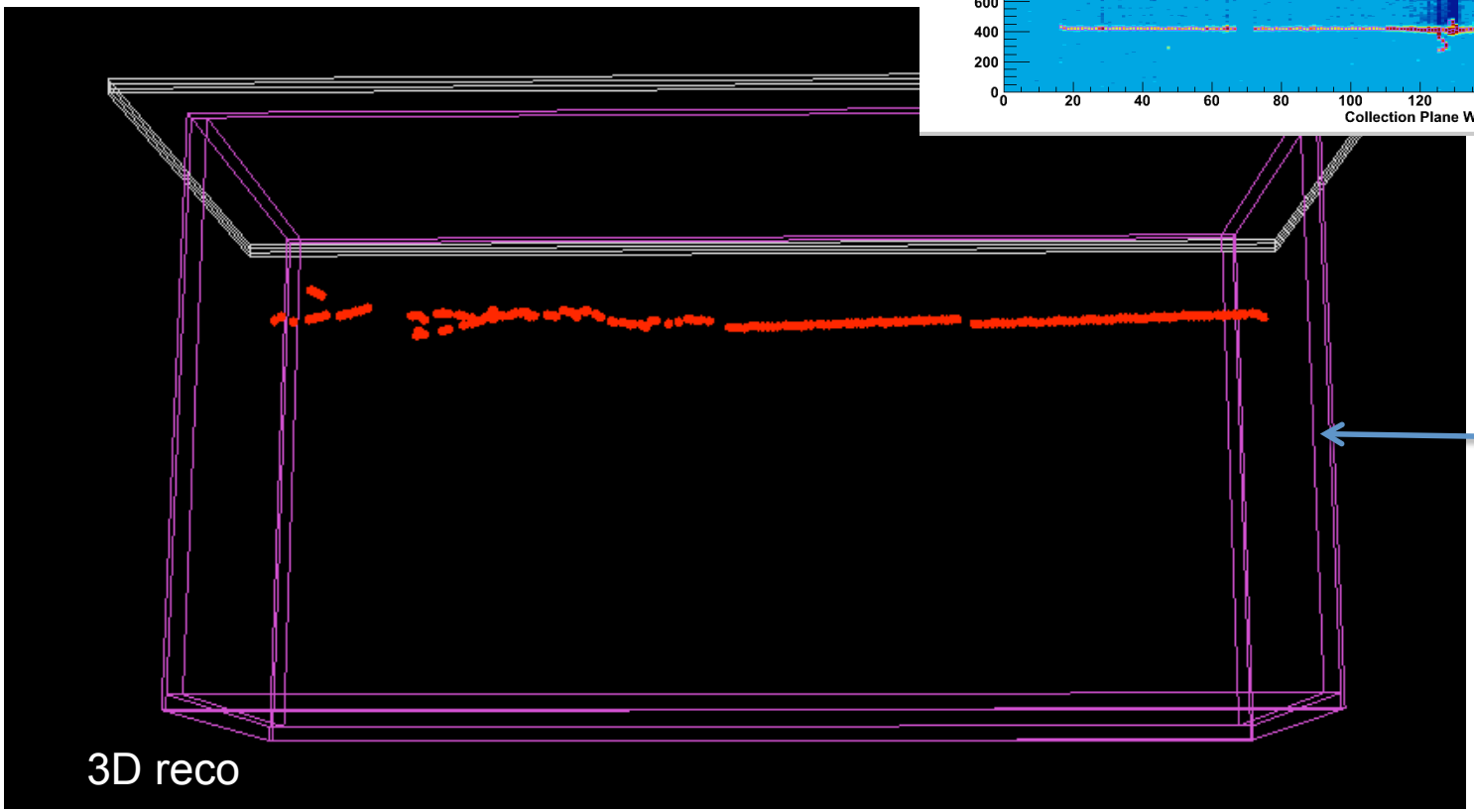
Run 628 Event 1920: crossing muon

Hit by Hit Reconstruction

ϑ = 116°; φ = 90°;
Track Length = 79 cm;







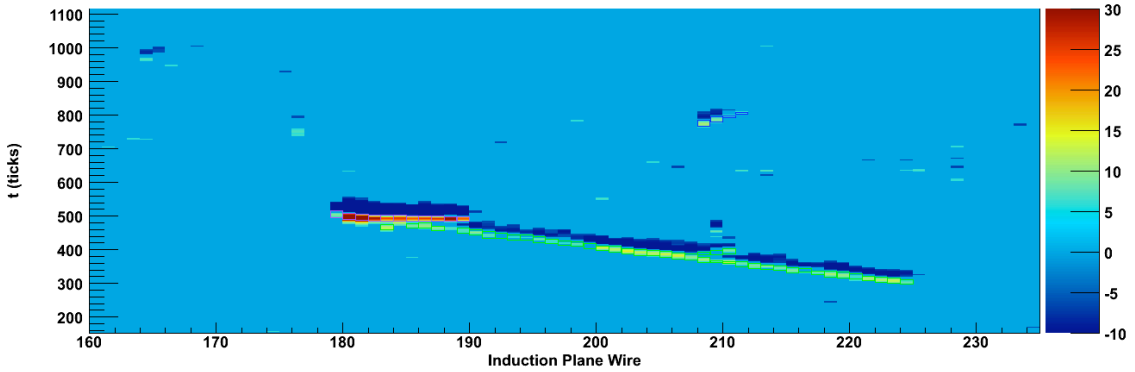
BEAM DIRECTION

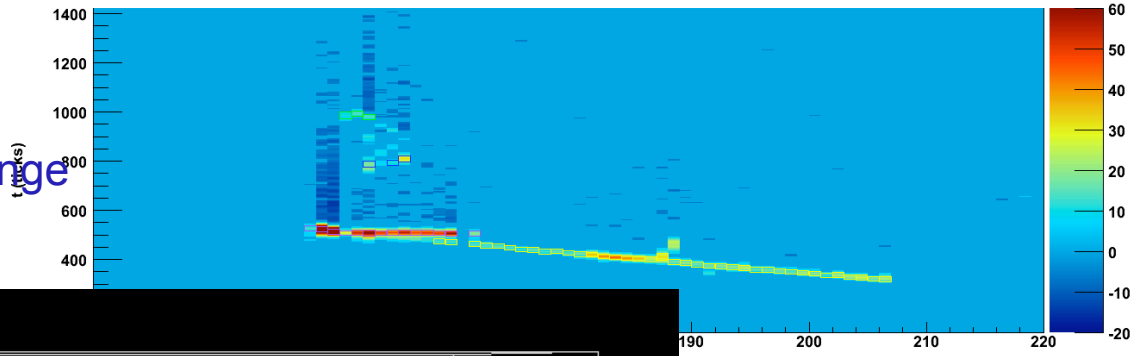
Run 568 Event 37350: ν_μ CC QE

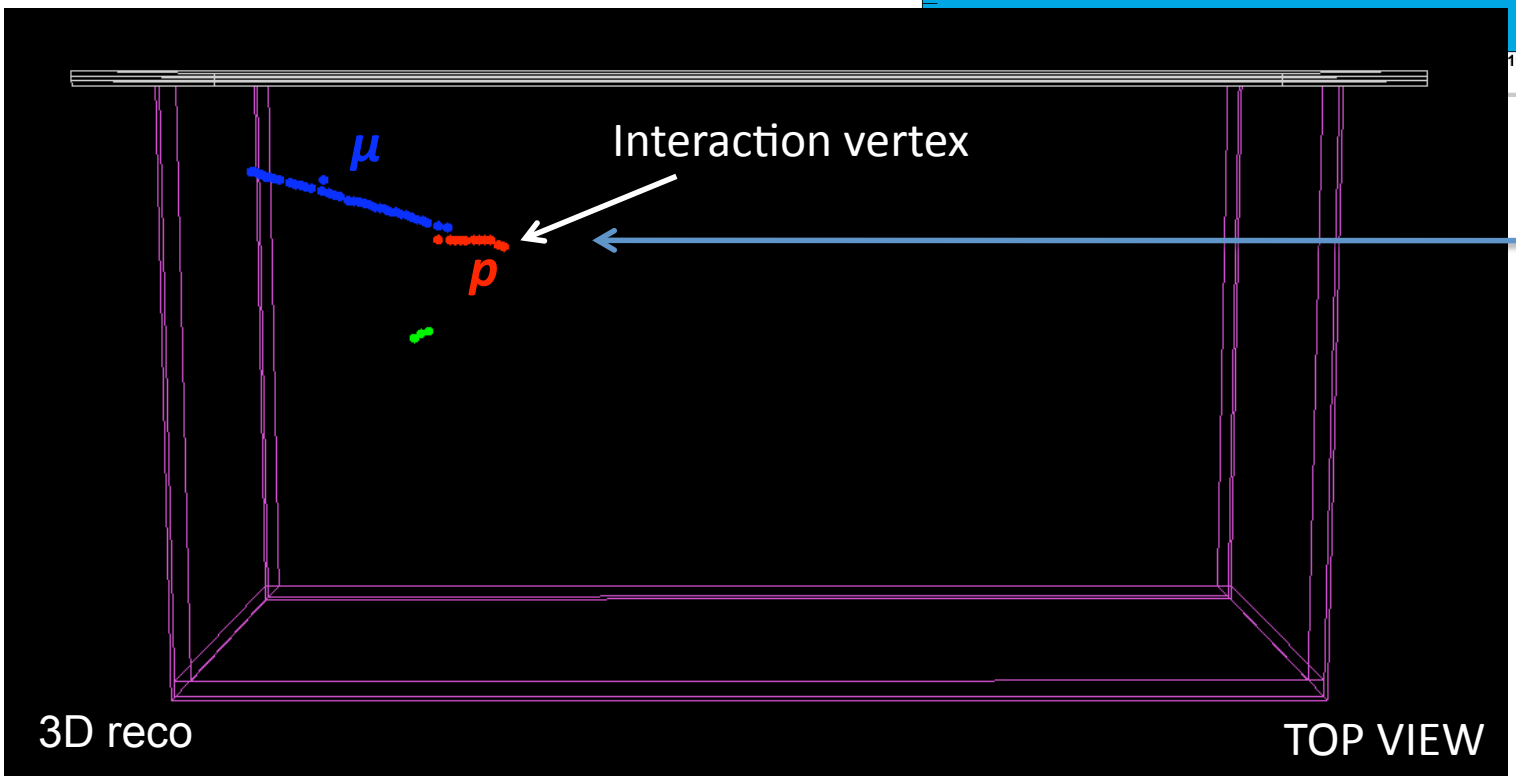
Hit by Hit Reconstruction

$\vartheta_\mu = 92°$; $\varphi_\mu = 106°$;
Track Length$_\mu$ = 20.8 cm;

$\vartheta_p = 86°$; $\varphi_p = 94°$;
Track Length$_p$ = 6.2 cm;
KinE_p = 85 MeV; → estimated from range
(NIST tables)







Details of the implementation in LArSoft

- Code Commitment will be done in few days
- New package “TrackFinder” created
- New Module “SimpleTracker” created (one external parameter → tolerance for time matching)
- Recob::Track and recob::Hit reconstructed objects are displayed in the evd::VolumeView display

Job Control: Simpletracker.xml

```
<job name="simpletrackerJob">
  <node module="caldata::CalWire" config="default" ana="0" reco="1"/>
  <node module="hit::FFTHitFinder" config="default" ana="0" reco="1"/>
  <node module="cluster::DBcluster" config="default" ana="0" reco="1"/>
  <node module="trkfinder::SimpleTracker" config="default" ana="0" reco="1"/>
</job>
```

Module Configuration
simpletrackerModule.xml

```
<config name="trkfinder::SimpleTracker" version="default">

      <param name="Input"> <string> "./clusters" </string>
      Input directory path
      </param>

      <param name="Output"> <string> "./tracks" </string>
      output directory path
      </param>

      <param name="tmatch"> <double> 22.0 </double>
      tolerance for time matching (in time sample)
      </param>

</config>
```

input

output

Algorithm Parameter

Next Steps for Reconstruction

- Matching with MINOS muon reconstruction (of interest for ArgoNeuT Analysis but also as validation)
- Calorimetric reconstruction
- Particle ID